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TEXAS AGRICULTURAL EXPERIMENT STATION

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DIVISION OF CHEMISTRY

THE COMPOSITION OF PEANUTS AND PEANUT BY-PRODUCTS

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*As of December 1, 1917.
**In cooperation with A. and M. College of Texas.
***On leave.
****In cooperation with United States Department of Agriculture.

CONTENTS.

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THE COMPOSITION OF PEANUTS AND PEANUT BY-PRODUCTS

BY G. S. FRAPS, PH. D., CHEMIST IN CHARGE; STATE CHEMIST.

The quantity of peanuts grown in Texas has increased steadily of late years. They are grown for feeding purposes, and for the manufacture of oil. The object of this bulletin is to discuss the composition of the peanut and its various by-products.

PEANUT HAY.

There are three varieties of peanut hay:

(1) *Peanut hay (mowed).* Sometimes the tops are cut off with a mower, and made into hay. The product is peanut hay, and is secured in an analogous manner to other hays.

(2) *Peanut hay with nuts.* The vines, with the nuts on them, are pulled up, and cured into hay. The product contains nuts, roots and vines. It produces a rich hay. It differs from other hay, however, by containing roots. Unless care is taken in the gathering, dirt is likely to be present, with injurious effect to the animals.

(3) *Peanut hay without nuts.* The vines are pulled and cured and the nuts threshed off. The hay (with some roots and a few nuts) is baled. This product corresponds in origin to a straw, but is a much superior feed. Unlike a straw, it contains some roots. In threshing, care should be taken to separate the dust and dirt from the hay. The dirt is likely to be injurious to animals, and to decrease the market value of the hay if it is sold.

Composition and feeding value. The average composition and feeding value of these three varieties of peanut hay (taken from Texas Bulletin No. 203) are given in Table 1.

A few other feeds are given for the purpose of comparison.

The digestible protein and the productive values show most clearly the feeding value. The digestible protein is of more importance to growing animals and milk cows than it is for fattening animals or working animals, as the growing animals need protein for the production of flesh and the cows need it for elaboration of milk.

All classes of animals need the productive value (expressed as fat) for the purpose of heat, energy, fat or milk formation. This is discussed fully in Texas Bulletin No. 170.

An examination of Table 1 shows that peanut hay without nuts has a higher productive value than alfalfa hay, but contains less digestible protein. It ranks higher in productive value than almost any other hay. This means that the peanut hay (without nuts) has a high feeding value. Peanut hay alone would make a good maintenance ration for cattle, sheep or horses, and would put a small amount of fat on

cattle, or serve as a ration for horses doing light work. It is said to be somewhat too laxative for horses doing much work, to serve as the sole roughage.

Table 1.—Percentage composition and feeding value of peanuts and other feeds.

	Number averaged.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.	Digestible protein.	Productive value.
Peanut hay, mowed, ave...	3	11.09	5.09	21.94	42.11	10.00	9.77	7.10	10.9
Peanut hay, without nuts, average.....	10	9.55	3.08	24.30	45.33	9.50	8.24	6.11	10.6
Peanut hay, with nuts, ave	4	13.22	13.12	23.75	34.95	8.19	6.77	10.00	15.6
Alfalfa hay, average.....	86	14.76	1.93	28.42	37.35	9.12	8.39	11.00	8.7
Bermuda hay.....	11	7.17	1.75	24.90	49.39	8.87	7.92	3.70	7.3
Prairie hay, Texas.....	10	4.38	2.13	28.97	48.79	8.16	7.57	0.50	7.1
Rough rice, ground, ave...	.....	8.09	1.80	8.89	64.52	11.68	5.02	6.10	15.9
Wheat bran average.....	.....	16.59	4.03	8.84	54.87	9.86	5.75	12.50	12.0

Peanut hay with nuts contains so many peanuts that it is really a concentrate and roughage combined, rather than solely a roughage. It has higher productive value than wheat bran, and is close to rough rice. Peanut hay with the nuts contains so much oil or fat that, if fed in quantity, it is likely to impair the appetite or digestion of the animal. Hence it would not be desirable to feed more than eight or nine pounds per day per head to cattle, making up the balance of the roughage with other coarser fodder, and using concentrates according to the object of the feeding.

Table 2.—Percentage composition of peanut vines, ground, commercial.

Lab. No.		Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
17599	.....	10.28	3.60	20.23	48.60	8.89	8.40
17883	.....	10.06	3.84	21.95	45.93	8.49	9.73
17885	.....	9.69	6.61	28.37	35.25	10.18	9.90
17963	.....	9.54	5.27	27.85	37.57	9.15	10.62
18336	.....	9.91	2.44	20.46	46.03	9.33	11.80
	Average (5).....	9.89	4.35	23.77	42.67	9.21	10.09
	Average 3 lowest in fibre....	10.09	3.29	20.89	46.85	8.90	9.98
	Average 2 highest in fibre....	9.62	5.94	28.10	36.41	9.67	10.26

Ground peanut hay is also sold in Texas, or used in mixed feeds. Some analyses are given in Table 2. The five samples differ widely in crude fiber. The average of the three lowest in crude fiber is 20.89 per cent.; of the two highest, 28.10 per cent. The difference may be, in part, caused by the amount of leaves retained in the hay; the more leaves, the better the hay and the lower the crude fiber.

WHOLE PEANUTS.

A number of samples of Texas peanuts were obtained for us by the Feed Control Service and subjected to analysis. The pops, sticks, etc.,

were first separated, and the cleaned nuts separated into hulls and kernels. The hulls and kernels were analyzed separately and the results combined to the whole clean peanuts. These are all Spanish peanuts.

Table 3.—Percentage composition Spanish whole peanuts (Texas).

Lab. No.	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Water.	Ash.	Per cent. meats.	Per cent. pops.	Per cent. trash.
11233- 4	22.86	35.39	18.33	12.99	5.57	4.86	74.1	.....	.....
11236- 7	22.57	34.95	17.92	14.30	5.31	4.95	74.1	.....	.....
11513- 62	24.37	36.59	16.17	14.14	5.72	3.01	76.7	2.20	7.80
11514- 63	24.87	37.97	14.77	13.53	5.64	3.22	77.6	2.40	5.20
12433- 36	25.30	36.07	16.98	13.28	5.96	2.41	75.2	3.72	1.71
12434- 37	24.10	37.55	17.65	11.95	6.15	2.60	72.8	.....	.....
12445- 61	24.90	33.70	19.72	13.30	5.39	2.99	67.3	4.29	9.74
12446- 62	28.09	36.83	16.02	10.64	5.96	2.45	75.5	1.82	1.71
12447- 63	28.19	34.61	15.34	15.07	4.26	2.53	76.5	1.76	2.25
12448- 64	26.45	36.70	15.88	13.10	5.64	2.22	76.9	1.32	3.15
12449- 65	27.63	36.30	16.39	11.56	5.73	2.40	75.0	1.20	1.20
12450- 66	25.50	36.90	17.62	12.62	5.13	2.21	74.2	1.69	6.89
12467- 91	26.42	39.93	15.71	9.56	5.96	2.42	78.8	2.61	3.00
12468- 92	24.89	39.04	16.79	10.82	6.13	2.31	76.4	1.36	3.65
12469- 93	25.17	39.22	16.37	11.08	5.89	2.26	77.1	2.84	3.92
12605- 82	26.31	39.66	15.24	10.32	5.19	3.28	79.9	5.36	2.32
12611-709	25.66	40.05	15.27	10.33	5.98	2.70	78.9	0.69	0.92
12612-710	26.25	37.14	16.06	11.82	5.94	2.79	77.74	0.35	1.55
12614-711	26.28	40.18	15.83	11.07	4.66	1.99	78.9	0.19	1.71
12615-712	26.88	35.74	17.24	11.31	4.87	3.96	73.1	5.92	12.19
12617-713	25.13	34.23	17 03	15.28	5.22	3.11	67.1	5.77	13.65
12618-714	26.89	35.86	18.23	10.84	5.27	2.92	73.0	4.02	3.22
12741- 81	25.60	33.39	21.52	10.42	6.73	2.33	66.9	0.80	1.01
12435- 38	23.09	37.55	17.75	12.68	6.03	2.89	72.3	5.55	7.38
12736- 82	24.50	37.47	20.60	9.53	5.85	2.05	73.2	0.00	0.20
12742- 83	24.93	35.55	18.90	13.31	5.18	2.12	76.4	0.00	.20
12633-784	25.86	35.35	18.67	11.49	5.92	2.69	72.2	2.03	3.41
12623-785	25.76	38.84	16.57	11.16	5.52	2.15	75.8	0.00	16.39
12620-786	25.93	34.02	19.12	12.01	5.75	3.15	70.4	10.54	4.11
12731- 87	26.18	36.96	17.03	10.21	6.82	2.78	76.0	1.08	2.34
12693-788	27.69	36.92	14.95	9.15	6.96	4.33	76.7	1.17	9.54
12706- 89	21.29	32.93	23.93	12.73	6.66	2.47	67.8	0.00	32.21
12734- 90	27.09	36.83	15.71	11.58	6.16	2.64	77.4	0.56	0.00
12743- 91	27.48	37.40	16.10	10 95	5.69	2.37	77.3	1.97	2.14
12694-792	23.44	37.62	18.52	13.26	5.03	2.12	72.5	0.00	1.90
12632-793	26.06	39.39	17.05	10.18	5.05	2.26	77.8	0.77	4.59
12681-794	27.35	38.72	14.90	11.52	5.18	2.33	79.1	.....	.....
12619-795	26.55	37.84	16.76	11.12	5.21	2.53	75.6	2.69	2.78
12732- 96	24.55	35.55	18.73	12.35	6.50	2.32	74.5	1.31	0.38
12733- 98	25.73	38.05	16.44	12.08	5.58	2.13	77.2	2.09	3.04
12631-799	24.18	37.69	18.31	12.11	5.20	2.50	72.7	0.86	4.62
12735-800	27.33	36.77	18.38	9.23	6.02	2.27	74.6	1.55	3.36
12754-805	27.93	35.97	16.64	10.85	5.42	3.17	73.3	2.54	4.57
12755-806	28.40	37.10	16.21	9.89	5.39	3.01	75.1	3.22	2.55
12756-807	25.35	36.89	16.81	12.96	5.56	2.43	76.6	0.20	.49
12757-808	25.13	34.72	17.20	13.32	5.98	3.65	73.0	2.45	5.01
12918- 28	26.20	36.46	14.62	14.20	5.79	2.74	77.4	3.57	4.32
12917- 29	26.19	35.65	17.12	13.14	5.11	2.79	71.8	3.44	3.66
12916- 30	24.54	32.94	19.62	14.06	6.00	2.84	69.4	3.62	5.23
12915- 31	27.07	34.73	16.70	12.60	6.19	2.71	75.1	2.76	4.34
12804-932	23.88	37.99	17.50	13.29	5.31	2.01	76.20	0.00	0.37
12522- 23	24.04	35.94	17.54	11.67	5.75	5.06	71.66	.....	.....
12936- 58	23.61	33.71	20.17	14.47	5.29	2.75	69.69	3.26	10.07
12937- 58	23.88	36.09	18.97	12.71	5.64	2.71	72.01	0.38	3.33
12938- 58	25.13	38.89	16.36	12.24	4.96	2.42	77.03	0.18	0.63
12939- 58	27.44	39.48	14.45	10.84	5.43	2.36	79.36	0.41	1.64
12940- 58	21.89	31.98	22.01	15.50	5.48	3.12	67.17	0.00	0.14

The whole clean Texas Spanish peanuts contain, on an average, 25.54 per cent. protein and 36.63 per cent. fat. (See Table 8.) The ten highest in fat contain 39.46 per cent. fat, while the ten lowest contain 33.62 per cent., a difference of 5.84 per cent. The ten highest in fat contain 77.9 per cent. meats, while the ten lowest contain 69.5 per cent., a difference of 8.4 per cent.

The ten highest in fiber are little higher in fat than the ten lowest in fat, while the ten lowest in fiber are only a litttle lower in fat than

the ten highest in fat. That is to say, a high fiber content, which is associated with a low meat content, is also associated with a low fat content.

There is a difference of 4.69 per cent. protein between the ten highest in protein and the ten lowest in protein, associated with a difference of 1.6 per cent. in fat.

This leads to the conclusion that, for trade purposes, an approximate opinion as to the quality of whole peanuts may be based upon the percentage of meats present. For exact data, a chemical analysis is, of course, necessary, but the quantity of meats offers a rough approximate method of judging the quality of a shipment on the average, and also allowing for the trash and dirt present. This is discussed later.

Digestion experiments with peanuts are reported in Texas Bulletin No. 203. Table 8 shows the average composition, and Table 33 the feeding value of the whole peanuts. On account of their high oil contents, peanuts have a productive value greater than corn, cotton seed meal, kafir corn or other ordinary concentrates, but on account of their high oil content they may not be fed in more than moderate amounts (except to pigs), as the oil may derange digestion if more than a moderate quantity is fed.

Table 4 shows the analyses of some Texas peanuts as made for a Texas oil mill in the season of 1915-16. The average percentage of meats in the clean nuts is 74.4 per cent.; the average percentage of pops and trash is 13.9 per cent., or nearly 280 pounds per ton. Pops are peanuts which contain no kernel.

Table 4.—Analysis of whole peanuts for a Texas oil mill.

Date.	Per cent. hulls.	Per cent. meats.	Per cent. water.	Per cent. oil.	Per cent. ammonia.	Per cent. pops.	Per cent. trash.	Total oil. gals.	Total oil. lbs.
Nov. 18, 1915	25.9	74.1	9.02	32.54	4.68	4.7	5.4	85	650
Nov. 18, 1915	28.5	71.5	7.13	32.21	4.72	6.8	9.5	86	644
Nov. 22, 1915	25.0	75.0	7.25	34.15	4.77	5.5	13.3	91	683
Nov. 22, 1915	28.6	71.4	6.87	36.41	4.97	4.1	7.5	97	728
Nov. 18, 1915	22.2	77.8	6.75	33.62	4.16	0.6	10.9	89	673
Nov. 24, 1915	24.8	75.2	6.48	35.18	.....	3.4	11.2	93	703
Nov. 24, 1915	22.8	77.2	6.91	33.00	.....	0.6	4.3	88	660
Nov. 18, 1915	25.7	74.3	7.98	34.27	4.38	4.9	10.2	91	685
Nov. 13, 1915	20.8	79.2	7.30	34.73	4.69	2.0	13.0	92	697
Nov. 13, 1915	27.8	72.2	7.12	34.78	4.77	9.0	32.0	92	698
Nov. 25, 1915	26.4	75.6	7.70	33.58	.....	2.5	6.7	89	672
Nov. 25, 1915	24.0	76.0	7.07	30.12	.....	4.4	7.9	80	602
Nov. 25, 1915	24.9	76.1	7.49	31.94	.....	1.0	9.1	85	639
Nov. 25, 1915	25.6	74.4	8.09	22.22	.....	2.9	20.0	59	444
Nov. 25, 1915	26.7	73.3	7.24	31.08	.....	4.6	11.0	82	624
Nov. 25, 1915	26.4	73.6	7.91	31.46	.....	1.5	11.3	84	629
Nov. 25, 1915	25.4	74.6	8.08	32.21	.....	4.3	8.3	86	644
Nov. 25, 1915	24.9	75.1	7.08	31.36	.....	1.7	6.0	83	627
Nov. 25, 1915	22.8	77.2	7.88	32.50	.....	1.6	6.0	86	650
Nov. 25, 1915	25.4	74.4	7.00	33.05	.....	3.1	9.0	88	661
Nov. 25, 1915	22.4	77.6	7.13	37.23	.....	1.8	1.3	99	744
Nov. 25, 1915	25.6	74.4	8.00	32.24	.....	1.9	9.9	86	645
Nov. 13, 1915	32.2	67.8	8.58	32.75	4.64	6.0	14.0	87	655
Nov. 13, 1915	23.8	76.2	7.96	33.39	4.75	8.0	11.0	89	667
Nov. 13, 1915	33.7	66.3	7.43	32.56	4.85	8.0	5.0	87	651
Nov. 13, 1915	26.6	73.4	7.10	35.29	4.91	11.0	6.7	94	708
Nov. 13, 1915	26.5	73.5	7.10	35.50	4.81	6.0	3.5	94	710
Nov. 13, 1915	27.4	72.6	7.28	36.48	4.44	12.0	1.0	97	729
Nov. 13, 1915	28.0	72.0	6.91	33.52	4.98	8.0	6.0	89	670
Nov. 13, 1915	24.3	75.7	8.40	34.42	4.44	8.0	8.0	91	688
Nov. 13, 1915	22.1	78.0	7.98	31.16	4.85	4.0	8.0	83	623
Nov. 13, 1915	24.2	75.8	7.07	34.06	4.87	5.0	8.0	91	681
Nov. 13, 1915	26.0	74.0	7.33	32.78	4.43	8.0	4.0	87	655
Average.....	24.9	74.4	7.47	33.08	4.69	4.8	9.1	88	662

Table 5 contains the analyses of some different varieties of peanuts made by the Alabama Experiment Station (Bulletin No. 193). The oil in the whole peanuts varies from 17.7 to 35.1 per cent., being highest in the Spanish varieties. To judge from these analyses, the only variety which should be grown for oil production is the Spanish variety. This is largely due to the large percentage of hulls in the other varieties.

Table 5.—Whole peanuts, Alabama analyses (Bulletin No. 193).

1911–1916.	Oil.	Meats.	On vines.	
			Per cent. stems.	Per cent. pops.
Virginia Runner	26.4	53.3	67	33
Tennessee Red	26.4	56.9	62	38
N. C. Runner	26.2	57.7	68	32
Virginia Bunch	21.1	46.0	62	38
N. C. Govern	27.4	56.6	.....	.....
Valencia	28.6	59.5	63	37
Red Spanish	34.7	72.1	61	39
White Spanish	35.1	75.1	62	38
Jumbo	17.7	39.3	.....	.....

Table 6 contains average analyses of whole peanuts, as reported by various commercial laboratories. The Texas peanuts average 50 per cent. more protein than the Georgia peanuts, according to these figures.

Table 6.—Whole peanuts—averages of some commercial laboratories.

	No. averaged.	Per cent. water.	Per cent. oil.	Per cent. meats.	Per cent. ammonia.	Oil gal. per ton.	Available oil.
Fort Worth Laboratories, 1916-1917, Texas	14	5.84	33.7	73.9	.....	89.7	.....
Houston Laboratories, 1916-1917, Texas	.....	6.1	38.1	77.2	.....	101.4	.....
Picard Law Co., Georgia, 1916-1917	.....	7.05	36.5	75.0	4.03	.....	84.0
Picard Law Co., Georgia, August, 1917	.....	9.9	35.6	75.5	3.96	.....	82.4

Table 7 contains some analyses of peanuts made for a Dallas oil mill, season of 1915-16.

Table 8 is a summary of the average composition of whole peanuts, as compiled from various sources. The Eastern peanuts here shown also contain less protein than the peanuts grown in Texas. They also contain more water; but the water content depends upon the extent to which the peanuts have been cured.

Table 7.—Whole peanuts, as analyzed for a Dallas Texas mill.

	Kernels.	Hulls.	Dirt.	Moisture in seed.	Oil in seed.	Ammonia in meats.	Total oil per ton seed. Gal.
	76.30	23.70	0.00	6.49	37.25	6.65	99.30
	76.20	22.79	1.01	6.03	35.48	6.25	94.60
	75.40	23.60	1.00	7.54	34.57	6.43	92.20
	75.08	23.98	.94	7.30	39.25	6.35	98.70
	72.02	24.84	.14	7.14	31.56	6.74	84.10
	76.75	22.44	.81	6.01	36.40	6.38	97.00
Average	75.29+	23.55+	0.65+	6.75+	35.75+	6.46+	94.31+

Table 8.—Average composition of whole clean peanuts.

	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Water.	Ash.	Meats per cent.
Average 57 Texas samples	25.54	36.63	17.34	12.07	5.65	2.77	74.5
Average ten highest in fat	25.91	39.46	15.96	10.76	5.47	2.41	77.9
Average ten lowest in fat	24.62	33.62	19.56	13.61	5.67	2.89	69.5
Average ten highest in fiber	24.10	34.17	20.45	12.80	5.79	2.65	70.0
Average ten lowest in fiber	26.75	38.06	15.09	11.61	5.65	2.85	78.1
Average ten highest in protein	27.75	37.01	15.94	10.97	5.60	2.72	76.3
Average ten lowest in protein	23.06	35.42	19.26	13.36	5.61	3.29	71.8
Average six Eastern samples (Texas Bulletin 170)	21.83	32.78	18.89	15.73	8.03	2.45	75.0
One sample, N. C. Bulletin 90B	23.18	34.99	18.39	14.15	6.57	2.68	.....
Average Alabama analyses (Spanish calculated)	20.23	35.35	18.86	15.96	6.67	2.94	.....
Average Houston, Texas, oil mill	24.15	33.08	.....	.....	7.47	.....	74.4
Average Picard Law of Georgia	20.75	36.50	.....	.....	7:05	.....	75.0
Average Dallas sample	.....	35.75	.....	.....	6.75	.....	75.3

PEANUT HULLS.

The composition of the peanut hulls from peanuts collected in Texas is given in Table 9.

These consist of the clean hulls, free from meats. This is shown by the percentage of oil they contain. Peanut hulls free of meats have a low oil content; and when any meats are present the oil rises rapidly. The percentage of meats may be estimated from the oil content of the hulls.

Table 9.—Peanut hulls (Texas) separated by hand.

Laboratory number.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
11233	6.38	1.59	58.56	14.53	7.07	11.87
11236	6.29	1.45	58.51	14.45	7.29	12.01
11430	8.67	5.09	51.87	23.21	8.63	2.63
11510	5.00	0.45	60.35	20.70	8.31	5.19
11562	6.26	0.57	63.01	17.89	8.43	3.84
11563	6.66	0.96	57.07	20.08	8 67	6.56
11570	5.00	0.57	65.75	17.96	8.61	2.11
12436	6.50	0.94	61.95	20.58	7.00	3.03
12437	6.62	0.71	59.27	22.95	7.13	3.32
12438	6.81	0.81	58.14	23.35	7.15	3.66
12461	7.69	0.50	54.99	25.12	7.34	4.36
12462	6.06	0.62	58.49	22.59	8.13	4.11
12463	6.44	0.81	57.53	24.23	6.75	4.24
12464	5.50	0.73	60.76	21.49	8.34	3.18
12465	5.69	1.70	60.20	21.68	8.20	3.53
12466	6.81	0.36	61.67	20.09	6.98	3 09
12491	6.12	0.73	63.87	18.71	7.86	2.80
12492	5.94	0.94	63.94	18.88	7.52	2.78
12493	5.56	0.86	63.88	19.61	7.42	2.67
12523	6.06	0.90	55.87	17.57	7.51	12.09
12616	8.09	3.46	50.97	27.14	6.78	3.56
12625	9.35	2.64	56.93	21.48	6.58	3.02
12682	6.69	1.09	66.60	10.03	7.66	7.93
12709	5.25	0.99	63.53	18.24	7.94	4.05
12710	6.13	0.73	62.44	20.81	7.13	2.76
12711	4.88	0.89	66.46	18.97	6.39	2.41
12712	9.25	0.91	57.52	17.41	6.72	8.19
12713	9.85	1.17	47.39	30.72	6.78	4.09
12714	7.36	0.78	61.21	19.03	7.44	4.18
12781	7.88	1.68	60.72	18.22	8.71	2 79
12782	4.72	0.31	70.69	13.84	8.14	2.30
12783	5.10	0.47	71.96	12.81	6.84	2.82
12784	7.66	0.98	60.84	19.91	7.35	3.26
12785	6.62	1.64	60.80	20.90	7.30	2.74
12786	7.94	1.21	59.34	19.20	7.51	4.80

Table 9.—Peanut hulls (Texas) separated by hand—Continued.

Laborato,y nvmber.	Protein.	Ether extract.	Crude fiber.	Nitro-gen-free extract.	Water.	Asq.
12787	6.94	0.53	62.59	17.41	7.92	4.53
12788	6.75	0.85	56.30	16.16	9.46	10.48
12789	4.53	0.21	69.66	15.85	7.69	2.06
12790	8.12	1.80	62.47	16.59	7.68	3.34
12791	6.12	1.29	62.58	19.36	7.35	3.30
12792	6.81	1.45	61.59	20.72	6.74	2.69
12793	5.69	0.56	67.15	16.70	6.88	3.13
12794	6.25	1.18	63.41	19.01	6.74	3.41
12795	6.56	0.74	61.81	20.86	6.55	3.48
12796	6.81	0.51	66.09	17.49	7.02	2.08
12798	6.56	0.71	64.48	18.86	6.78	2.61
12799	6.19	0.56	60.42	21.47	7.28	4.08
12800	7.00	0.55	65.52	18.42	6.16	2.35
12805	8.88	1.95	55.10	22.38	7.09	4.60
12806	8.10	1.29	57.72	21.55	7.16	4.18
12807	6.44	0.59	64.50	18.01	7.41	3.05
12808	8.25	0.99	57.44	19.72	7.57	6.03
12928	6.75	1.40	56.11	23.82	8.39	3.53
12929	9.82	2.45	54.30	22.05	7.28	4.10
12930	8.19	1.29	58.31	19.44	8.23	4.54
12931	6.56	0.80	60.08	20.76	8.30	3.50
12932	6.07	0.79	65.49	17.45	7.79	2.41
12958	6.03	1.17	61.19	20.70	6.88	4.03

The peanut hulls vary decidedly in crude fiber content. This is shown in the table, and also in the averages of the ten samples highest in fiber and the ten lowest in fiber, given in Table 10. The fiber content differs between these two groups 12.6 per cent., and differs 6 to 7 per cent. from the average.

Table 10.—Peanut hulls, average analyses.

	Protein.	Ether extract.	Crude fibre.	Nitro-gen-free extract.	Water.	Ash.
Average (58) Texas	6.76	1.10	60.83	19.64	7.48	4.19
Average ten highest in fiber	5.64	0.59	67.55	15.95	7.31	2.96
Average ten lowest in fiber	7.87	2.02	54.95	21.90	7.77	5.49
Average 26, Henry and Morrison	7.3	2.60	56.60	18.90	9.1	3.3
Average 16, Miscellaneous, Texas Bulletin 203	6.10	1.29	63.47	16.18	9.03	3.92
Average of 4, some meats present, Texas Bulletin 203	8.16	3.82	55.60	19.12	9.53	3.78
Average of 5, Farmers' Bulletin 751	7.06	2.26	71.68	9.33	5.35	4.32
Commercial	6.05	2.83	54.03	15.50	8.05	13.54

Peanut hulls are comparatively low in ash, and also in ash insoluble in hydrochloric acid (insoluble ash). A high ash content is due to dirt adhering to the hulls or with them.

Table 10 contains the average for various samples of peanut hulls. The hand-separated hulls are lower in fat and protein and higher in fiber than commercial peanut hulls as procured from the mills. This is seen in the table.

PEANUT KERNELS.

The composition of the Texas peanut kernels as collected for analysis is shown in Table 11.

Table 11.—Peanut kerneis. (Texas.)

Laboratory number.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
11234	28.63	47.21	4.26	12.45	5.04	2.41
11237	28.26	46.66	3.74	14.25	4.61	2.48
11513	30.25	47.57	2.75	12.15	4.93	2.35
11514	30.13	48.65	2.57	11.63	4.77	2.25
11569	31.12	48.50	2.30	11.57	4.42	2.09
12433	31.50	47.66	2.16	10.86	5.61	2.21
12434	30.63	51.32	2.10	7.84	5.78	2.33
12435	29.32	51.62	2.27	8.59	5.60	2.60
12445	33.25	49.83	2.58	7.57	4.45	2.32
12446	35.25	48.58	2.24	6.76	5.26	1.91
12447	34.88	44.99	2.38	12.26	3.49	2.00
12448	32.75	47.50	2.39	10.59	4.83	1.94
12449	34.63	47.66	2.40	8.32	4.95	2.04
12450	32.00	49.26	2.31	10.03	4.49	1.91
12467	31.88	50.48	2.76	7.11	5.45	2.32
12468	30.75	50.81	2.23	8.33	5.71	2.17
12469	31.00	50.61	2.26	8.55	5.44	2.14
12522	31.12	49.77	2.40	9.35	5.07	2.29
12615	33.37	48.55	2.42	9.07	4.18	2.41
12618	34.12	48.83	2.33	7.81	4.46	2.45
12631	30.94	51.64	2.50	8.60	4.41	1.91
12632	31.88	50.48	2.75	8.32	4.52	2.05
12633	32.87	48.59	2.44	8.26	5.37	2.47
12685	33.87	47.38	2.20	8.64	4.86	3.05
12686	31.50	49.87	2.06	9.50	4.66	2.41
12687	33.50	48.73	2.45	7.72	5.13	2.47
12688	34.62	47.26	2.37	8.07	5.02	2.66
12693	34.06	47.88	2.38	7.01	6.21	2.46
12731	32.25	48.46	2.65	7.94	6.48	2.22
12732	30.62	47.55	2.52	10.59	6.32	2.40
12733	31.38	49.08	2.26	10.08	5.22	1.98
12734	32.62	47.05	2.06	10.12	5.71	2.44
12735	34.25	49.10	2.33	6.10	5.98	2.24
12736	31.75	51.08	2.25	7.95	5.02	1.95
12741	34.37	49.08	2.12	6.56	5.76	2.11
12742	31.06	46.39	2.51	13.47	4.67	1.90
12743	33.75	48.01	2.45	8.49	5.20	2.10
12754	34.87	48.36	2.63	6.65	4.82	2.65
12755	35.13	48.97	2.45	6.02	4.81	2.62
12756	31.12	47.97	2.24	11.42	5.00	2.25
12757	31.37	47.19	2.31	10.96	5.40	2.77
12804	29.44	49.61	2.52	12.00	4.54	1.89
12915	33.87	45.98	2.32	9.90	5.48	2.45
12916	31.75	46.90	2.56	11.69	5.01	2.09
12917	32.62	48.69	2.52	9.64	4.26	2.27
12918	31.87	46.69	2.51	11.40	5.02	2.51
12936	31.25	47.83	2.34	11.99	4.37	2.22
12937	30.97	49.71	2.57	9.36	5.17	2.22
12938	30.75	50.16	3.00	9.74	4.40	1.95
12939	33.00	49.41	2.31	8.50	4.81	1.97
12940	29.63	47.05	2.85	12.98	4.80	2.69
12706	29.25	48.46	2.21	11.25	6.16	2.67
12694	29.75	51.34	2.18	10.44	4.39	1.90
12620	33.50	47.81	2.22	8.99	5.02	2.46
12617	32.62	50.45	2.14	7.70	4.46	2.63
12619	33.00	49.82	2.22	7.97	4.77	2.22
11508	32.75	46.86	2.48	11.36	4.00	2.55
12605	31.25	49.36	2.31	10.40	4.57	2.11
12611	31.12	50.49	2.37	8.21	5.47	2.34
12612	32.12	47.76	2.52	9.20	5.60	2.80
12614	32.00	50.69	2.29	8.96	4.19	1.87
12623	31.87	50.71	2.45	8.05	4.95	1.97
12681	32.92	48.64	2.08	9.55	4.76	2.05

This table represents the kernels free from hulls, as shelled from the Spanish peanuts collected in Texas. In Table 15 is shown the average of the ten highest in fat and the ten lowest in fat. The difference is 4.4 per cent., and they also differ 2.2 per cent. from the average.

Table 15 also shows the average of the ten highest in protein and the ten lowest in protein. They differ 5 per cent. in protein and also 2.5 per cent. from the average.

Table 12.—Peanut kernels (without hulls).

Laboratory number.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
17148	31.07	48.69	2.03	10.65	5.26	2.30
17149	30.69	48.23	2.08	12.11	4.71	2.18
17150	30.88	48.78	2.40	10.62	5.19	2.17
17151	32.07	47.85	2.22	9.53	6.09	2.24
17152	31.63	48.10	2.07	10.83	5.22	2.15
17153	30.90	48.18	3.05	10.52	5.11	2.24
11234–7	28.45	46.93	4.00	13.35	4.83	2.44
11508	32.75	46.86	2.48	11.36	4.00	2.55
11513	30.25	47.57	2.75	12.15	4.93	2.35
11514	30.13	48.65	2.57	11.63	4.77	2.25
2200	20.50	54.15	2.60	16.85	4.08	1.82
2201	24.10	52.64	3.83	12.78	4.38	2.27
Average	29.45	48.89	2.67	11.87	4.88	2.24

Table 13.—Peanut kernels, grown at Florence, S. C., (Farmers' Bulletin 751).

	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Water.	Ash.
Virginia Runner	29.60	46.58	2.73	14.98	3.35	2.76
Virginia Bunch	29.52	45.73	2.84	15.52	3.28	3.11
Spanish	31.20	49.10	2.30	12.43	3.30	2.67
Valencia	33.64	49.60	2.13	8.21	3.75	2.67
African	30.30	45.90	2.26	14.78	3.45	3.31
Average	30.85	47.38	2.45	13.00	3.42	2.90

Table 12 contains some additional analyses of Texas peanut kernels.

Table 13 contains the analyses of five varieties of peanut kernels, grown under the same conditions at Florence, S. C. (Farmers' Bulletin No. 751.) The Spanish variety is higher in oil than the others.

Table 14 shows the analyses of some varieties of peanuts grown in Alabama. These samples contain decidedly less protein than those shown in the preceding tables. They indicate that the peanuts grown in the East probably contain less protein than those grown in Texas.

Table 14.—Peanut kernels, Alabama analyses.

1915	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Water.	Ash.	Oil. 1916
Tennessee Red	27.63	45.70	2.51	15.26	6.45	2.45	46.06
Red Spanish	25.44	48.60	2.62	14.54	6.35	2.45	47.57
Improved Virginia	26.06	43.68	2.98	17.92	7.05	2.40	48.93
N. Carolina Running	25.44	40.86	2.60	21.20	7.42	2.48	50.13
Improved Valencia	28.50	47.42	2.54	13.46	5.65	2.43	48.78
Virginia Bunch	23.44	45.27	3.16	19.36	6.32	2.45	45.27
Jumbo	24.44	45.15	2.83	18.73	6.25	2.60	.....
McGovern	.....	.....	.....	.....	.....	.....	48.47
White Spanish	.....	.....	.....	.....	.....	.....	45.03
Average	25.85	45.23	2.75	17.20	6.50	2.47	54.32

Table 15.—Peanut kernels, average.

	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Water.	Ash.
Average 63 Texas samples	32.06	48.73	2.44	9.48	5.01	2.28
Average ten highest in fat (Texas)	30.91	51.03	2.29	8.55	5.10	2.12
Average ten lowest in fat (Texas)	31.41	46.59	2.79	12.07	4.75	2.39
Average ten highest in protein (Tex.)	34.62	48.07	2.36	7.56	5.08	2.31
Average ten lowest in protein (Texas)	29.53	48.57	2.79	11.63	5.12	2.36
Average of six Tenn. samples, Texas Bulletin 203	27.27	43.07	2.53	17.25	7.70	2.11
Average 12 Spanish varieties, Farmers' Bulletin 751	.....	50.00	.....	.....	3.9	2.4
Average 19 Virginia varieties, Farmers' Bulletin 751	.....	41.7	.....	.....	4.1	2.7
Average of 11 Henry and Morrison	26.8	44.9	2.6	17.5	6.0	2.2
Average of 7 Alabama samples	25.85	45.23	2.75	17.20	6.50	2.47
Average of 5 grown in Georgia	30.85	47.38	2.45	12.00	3.42	3.90
Average of 11 Farmers' Bull. 25	27.16	45.34	3.96	13.14	7.85	2.55
Average 12 Texas samples	29.45	48.89	2.67	11.87	4.88	2.24

Table 15 contains the averages of the various analyses. These analyses show that Eastern peanuts contain less protein than Texas peanuts, on the average. The average peanuts analyzed by the Picard-Law Company of Atlanta, Ga., run 20.75 per cent. protein, and the composition of the kernels, calculated from this, would be about 25 per cent. protein, and this is in line with other Eastern analyses shown in Table 15. The average of the five Georgia samples is 30.55 per cent., showing that some Eastern peanuts may be as high in protein as some Texas peanuts; but, on the average, the Eastern peanuts are lower.

VARIATIONS IN PEANUTS.

Table 16 contains analyses of shriveled peanut kernels as compared with the average of the lot, which were mostly rounded. The small and shriveled peanuts average 0.1 gram each. The shriveled peanuts are much lower in oil. The presence of many shriveled peanuts will decrease the oil content of the lot.

Table 16.—Fat content of small and shriveled peanuts.

Laboratory number.	Fat content, shriveled.	Fat content, all.
12433	37.51	47.66
12434	35.68	51.32
12435	35.82	51.62
Average	36.34	50.20

Table 17.—Protein and fat content of single peanut kernels.

	12448		12449		12434		12435		12434		12435	
	Weight.	Per cent protein.	Weight.	Per cent. protein.	Weight.	Per cent. protein.	Weight.	Per cent. protein.	Weight.	Per cent. fat.	Weight.	Per cent. fat.
One kernel	.4818	33.52	.5118	40.00	.4072	26.40	.4320	27.95	.3588	54.10	.3072	56.74
One kernel	.5108	33.75	.5382	34.65	.4988	26.66	.3580	26.89	.3876	55.58	.4565	57.22
One kernel	.4180	33.21	.1776	39.41	.3636	40.19	.3426	38.56	.3990	57.79	.6008	52.18
One kernel	.5234	31.59	.4886	30.44	.2836	36.41	.3914	29.06	.3298	48.85	.3562	53.39
One kernel	.4506	32.82	.5162	38.31	.5680	35.12	.3092	35.94	.5186	49.75	.4636	48.26
One kernel	.2446	34.35	.1930	35.42	.4244	37.11	.3460	29.08	.2890	56.71	.3276	57.81
Average	.4382	33.21	.4042	36.37	.4243	33.65	.3632	31.25	.3805	53.90	.4187	54.27
Analysis	.....	32.75	.....	34.63	.....	30.63	.....	29.32	.....	51.32	.....	51.62

Table 17 contains analyses of single peanut kernels. The percentage of protein varies from 26.40 to 40.19 in one lot, and in another lot from 30.44 to 40. The percentage of fat varies from 49.75 to 57.79 in one lot and from 48.26 to 57.81 in the other lot. There is, of course, more chance for error in the analysis when using such small amounts. But the figures show that individual kernels may vary considerably in composition, and emphasize the importance of preparing a sufficient quantity of the kernels for analysis, to average up the inequalities. As the peanut kernels are comparatively large, the quantity prepared, should not be less than 10 grams, and it is better to prepare a larger quantity. If whole peanuts are used, not less than 20 grams should be taken.

WHOLE PRESSED PEANUTS.

Before expelling the oil from whole peanuts, they are first cleaned, so that sticks, trash, leaves, dirt, etc., are removed. They are then passed through the expellers. The oil is expressed, and the residue consists of whole pressed peanuts. If ground up, it is termed "ground whole pressed peanuts."

Table 18.—Commercial whole pressed peanuts (Texas).

Laboratory number.	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Water.	Ash.
16126	34.84	8.60	22.77	21.05	8.45	4.29
16289	35.33	9.64	23.01	19.65	8.89	3.48
16319	34.91	13.18	18.59	22.38	6.50	4.44
16358	34.16	10.72	20.53	19.63	8.44	6.52
16405	35.26	12.57	22.44	18.81	7.42	3.50
16521	38.31	8.77	18.13	19.79	11.45	3.55
16524	39.19	7.71	20.48	20.73	7.99	3.90
16576	16.25	15.05	26.15	16.20	7.53	18.82
16594	35.10	9.94	21.55	20.92	8.76	3.73
16791	34.19	11.06	20.94	20.75	7.43	5.63
16854	34.48	7.45	24.49	20.99	8.89	3.70
16853	34.73	8.65	24.67	20.88	7.23	3.84
16987	35.94	9.80	22.08	21.86	6.83	3.49
17530	37.06	7.30	20.99	22.61	9.13	3.91
17649	35.88	7.79	21.95	19.78	10.36	4.24
17749	34.50	8.58	22.43	20.94	9.55	4.00
17927	37.25	9.18	22.43	18.98	8.60	3.56
17903	32.16	10.81	23.89	21.62	7.44	4.08
17924	35.87	7.04	23.62	21.64	7.55	4.28
17925	37.00	6.79	24.74	22.39	5.00	4.08
17927	37.25	9.18	22.43	18.98	8.60	3.56
17763	33.25	9.46	17.50	20.06	8.60	11.13
18188	39.13	8.10	20.49	18.97	9.67	3.64
18199	38.19	9.70	23.74	17.84	7.53	3.00
18245	37.00	8.58	22.07	21.25	7.35	3.75
18262	39.07	8.08	20.83	21.93	6.07	4.02
18277	34.54	9.11	21.98	22.76	6.57	5.04
18286	34.19	9.91	23.10	20.58	9.05	3.17
18287	33.56	9.28	24.13	20.23	9.75	3.05
18322	34.53	8.72	19.23	25.34	7.33	4.35
18326	39.75	8.28	17.57	21.67	8.10	4.63
18333	34.00	8.57	19.16	26.61	6.47	5.19
18334	34.63	9.89	19.21	24.52	6.79	4.96
18392	33.57	7.73	22.56	22.40	9.37	4.37
18393	32.29	7.81	22.08	23.52	10.10	4.20
11431	38.19	8.43	19.74	22.01	7.55	4.08
11512	39.38	8.24	18.54	22.60	7.49	3.75
12037	35.82	9.22	22.33	22.26	6.71	3.66
11277	35.27	9.64	22.76	19.60	9.34	3.39
12440	36.13	9.45	22.38	21.61	6.78	3.65
17804	30.41	9.49	26.24	19.75	7.06	7.05
17846	36.37	7.96	22.77	21.41	7.49	4.00
17847	37.62	7.86	22.49	20.13	8.05	3.85
17903	32.16	10.81	23.89	21.62	7.44	4.08
17924	35.87	7.04	23.62	21.64	7.55	4.28
17925	37.00	6.79	24.74	22.39	5.00	4.08
16927	36.42	9.19	21.78	19.62	7.88	5.11
17550	36.91	7.76	21.25	21.14	7.87	5.07
17648	35.06	9.75	22.57	22.03	6.83	3.76
17748	36.13	8.77	21.23	20.65	8.80	4.12
17916	41.44	8.04	19.04	21.08	6.50	3.90
17926	36.25	9.96	22.25	20.07	7.86	3.61
17968	35.72	8.17	22.34	22.13	7.73	3.91
18077	36.56	8.93	22.12	20.54	8.20	3.65
18104	35.25	8.59	22.09	21.51	8.67	3.89
18142	36.35	9.02	22.87	17.16	11.28	3.32
Average	35.49	9.03	21.94	21.16	7.98	4.48

Table 18 shows the composition of some samples of whole pressed peanuts sold in Texas. Some of these were made from peanuts not properly cleaned, and, in one or two instances, they contain some dirt. The presence of dirt is shown by the high ash content.

Table 19 shows the composition of whole pressed peanuts, as made by a Texas oil mill in the fall of 1916.

Table 19.—Whole pressed peanuts as made by a Texas mill.

Date.	Protein.	Fat.	Moisture.
October 23, 1916	35.72	7.69	10.39
October 24, 1916	36.95	5.48	9.79
October 26, 1916	35.83	6.93	10.50
October 27, 1916	35.83	7.00	9.10
October 27, 1916	34.28	10.25	9.85
October 28, 1916	35.72	6.33	9.70
October 28, 1916	35.67	7.57	9.03
October 28, 1916	35.21	7.90	8.45
October 28, 1916	35.93	10.06	7.02
October 31, 1916	35.57	6.91	5.84
October 2, 1916	35.52	7.35	9.10
October 30, 1916	35.62	8.00	8.72
October 30, 1916	36.55	10.22	7.47
October 30, 1916	35.57	6.91	5.84
Average	35.71	7.75	8.62

Table 20.—Whole peanuts, products on 6 per cent. oil basis.

	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Water.	Ash.
Average	37.89	6.00	25.71	17.91	8.38	4.11
Average 10 highest in fat	40.23	6.00	24.75	16.78	8.50	3.74
Average 10 lowest in fat	34.87	6.00	27.75	19.26	8.03	4.09
Average 10 highest in fiber	34.43	6.00	29.22	18.29	8.27	3.79
Average 10 lowest in fiber	40.59	6.00	22.90	17.62	8.57	4.32
Average 10 highest in protein	41.42	6.00	23.78	16.38	8.36	4.06
Average 10 lowest in protein	33.52	6.00	28.00	19.42	8.15	4.78

Table 20 shows the composition of whole pressed peanuts, if made from the whole peanuts given in Table 8, and if reduced to 6 per cent. fat. These results were calculated by subtracting the ether extract from 100, which gives the fat-free residue; as the material is to be reduced to 6 per cent. fat, the fat-free residue is 94 per cent. of what will be obtained, and is accordingly divided by this figure. Each constituent of the peanuts is then divided by this figure.

For example, ether extract is 36.6 per cent.; fat-free residue is 100—36.6=63.4 per cent.; divided by 94, the residue containing 6 per cent. fat would be 67.4 per cent., or 100 pounds of the peanuts would give 67.4 pounds residue containing 6 per cent. fat, if nothing else is lost. These 67.4 pounds contain all the protein, and fiber, nitrogen-free extract and ash of the original peanut.

Thus:

$$P = \frac{N.\ 94}{(100 - F.)}$$

Where P is the protein content of the product containing 6 per cent. fat, N is the protein content originally, and F is the original fat content.

The crude fiber, etc., are secured in a similar way.

Examination of the table shows that the whole clean peanuts analyzed, reduced to 6 per cent. fat, contain on an average 37.89 per cent. protein, 25.73 per cent. crude fiber, 8.38 per cent. water.

The residue from the ten samples of peanuts highest and lowest in fat would contain 40.23 and 34.87 per cent. protein, respectively.

The residue from the ten peanut samples highest and lowest in fiber would contain 34.43 and 40.59 per cent. protein, respectively.

The residue from the ten peanut samples highest and lowest in protein would contain 41.42 and 33.52 per cent. protein, respectively.

According to these figures, Texas whole pressed clean peanuts (with 14 per cent. fat and water) should average 37.9 per cent. protein. Texas peanuts of better quality may yield a product as high as 41 per cent. protein, or higher, and Texas peanuts of inferior quality may yield a product as low as 33.5 per cent. protein, or even a little lower.

Peanuts as purchased by the mills always contain some stems, leaves, pops, and sometimes dirt. The pops are composed of shells only, and contain no meats. Table 3 shows the percentage of pops and the like found in some of the samples of peanuts collected.

The peanuts should always be cleaned before they are pressed, and this is usually done. Peanuts not properly cleaned will, of course, yield a product of lower quality than cleaned peanuts. It is not possible to remove all the pops.

On account of the variations in the composition of peanuts, it seems desirable to make two grades of whole pressed peanuts for Texas, one grade to contain 36 per cent. protein and 6 per cent. fat, the other grade to contain 33 per cent. protein and 6 per cent fat. A guarantee of 25 per cent. crude fiber could be permitted in the higher grade, and a guarantee of 28 per cent. in the lower grade. It is possible that in some sections of the United States the whole pressed peanuts might occasionally contain as low as 30 per cent. protein, but further investigation is required to establish this point.

If we compare Table 18 with Table 20, we find that the whole pressed peanuts actually on the market contain more fat and less crude fiber than those calculated. Even allowing for the higher fat and water content of the commercial whole pressed peanuts, the average crude fiber content is lower than the calculated average, and is almost the same as the average of those calculated from the peanuts lowest in crude fiber. That is to say, the crude fiber content of the whole commercial pressed peanuts is less than we would expect from the analyses of the peanuts made. Something similar to this is found to be the case with peanut cake and meal. Thus the peanuts actually worked up in the mills are probably better in fiber content than those we analyzed, though there may be some other reason for the difference.

Table 21 contains the average composition of peanut cake and meal as reported by two Texas commercial chemists. The samples were to some extent composed of whole pressed peanuts, as is evident from the analyses.

Table 21.—Peanut cake and meal (partly whole pressed peanuts).

	No. averaged.	Per cent. water.	Per cent. protein.	Per cent. oil.
Fort Worth Laboratories, Texas 1916-17	97	8.53	39.90	10.51
Houston Laboratories, Texas 1916-17		9.10	41.27	7.68

Table 22.—Average analyses of whole pressed Peanuts.

	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
English analyses, Voelcker	28.5	7.2	19.0	28.1	11.6	5.7
French, Pott	31.0	9.0	23.5	19.5	11.0	6.0
Texas analyses, all	35.5	9.0	21.8	21.2	8.0	4.5

Table 22 contains the average analyses of whole pressed peanuts, as given in the *Journal of the British Board of Agriculture*, July, 1915, and also the Texas figures.

The English and the French analyses both show a lower protein content than the Texas samples. The crude fiber is in one case lower, the other higher.

PEANUT CAKE AND MEAL.

Table 23 contains the analyses of Texas peanut cake or meal, which runs about 55 per cent. protein and fat combined, corresponding to choice cottonseed meal.

Table 23.—Peanut meal or cake, high grade (Texas).

Laboratory number.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
17139	51.44	11.16	4.49	23.25	5.16	4.50
17140	49.88	13.53	5.15	21.87	5.23	4.34
17141	44.82	21.88	5.73	19.42	4.11	4.04
17400	49.69	10.31	6.30	23.40	5.78	4.52
18038	50.87	7.45	7.06	21.67	7.67	5.28
15420	45.78	8.26	6.69	24.31	6.71	8.25
12040	41.94	14.81	8.34	23.26	6.51	5.14
12636	51.69	8.08	5.22	23.83	6.73	4.45
12626	59.37	6.93	4.63	17.67	6.83	4.57

Table 24.—Peanut cake or meal, medium grade (Texas).

Laboratory number.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
17142	45.88	8.20	10.12	25.55	5.52	4.73
17143	46.32	8.24	10.41	25.35	5.35	4.33
17144	47.00	7.94	10.80	24.25	5.36	4.65
17159	46.32	7.92	12.78	21.53	7.05	4.40
18039	44.00	9.58	13.56	20.27	8.14	4.45
17145	45.75	8.25	12.14	23.74	5.74	4.38
17146	45.32	8.81	12.10	23.66	5.69	4.42
17147	44.57	8.62	12.06	24.47	5.77	4.51
17158	46.31	9.69	10.59	22.65	5.94	4.82
16751	42.00	9.57	9.30	26.40	5.58	7.55
12441	39.08	8.28	18.74	23.21	6.80	3.89
12627	46.37	11.05	12.40	16.08	7.70	6.40
Average	44.91	8.84	12.08	23.05	6.22	4.83

Table 25.—Average analysis of peanut cake.

	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Water.	Ash.
German analyses	44.5	9.2	5.2	23.8	9.8	7.5
German (Rufisque)	50.8	7.0	4.4	24.3	9.0	4.5
English analyses, Voelcker	48.3	8.2	4.7	23.0	10.4	5.4
English analyses, Smithson	49.3	7.7	4.7	21.7	10.6	6.0
French analyses, Pott	48.0	7.3	5.0	24.5	10.0	5.2
Texas average, high grade, choice	49.5	11.4	5.9	22.1	6.1	5.0
Texas average, lower grade, prime	44.9	8.8	12.1	23.1	6.2	4.8

Table 24 contains similar analyses running about prime, or 51 per cent. protein and fat combined.

Table 25 contains the average analyses of peanut cake or meal. The foreign analyses are quoted from the Journal of the British Board of Agriculture, July, 1915.

All these average analyses run better than prime (51 per cent. protein and fat) and some are better than choice (55 per cent. protein and fat.) With some experience, Texas mills will no doubt reduce the fat content of this product, which is high.

PRESSED PEANUT KERNELS.

The composition of the residue left after expressing the oil from Texas peanut kernels has been calculated in the same way, already described for whole peanuts. It was assumed that 6 per cent. fat was left in the residue. The results of these calculattions are given in Table 26.

Table 26.—Pressed peanut kernels products on 6 per cent. oil basis.

	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
Average of all (63)	58.78	6.00	4.48	17.38	9.18	4.18
Average ten highest in fat	59.33	6.00	4.40	16.41	9.80	4.07
Average ten lowest in fat	55.30	6.00	4.91	21.25	8.36	4.21
Average ten highest in protein	62.80	6.00	4.28	13.70	9.02	4.19
Average ten lowest in protein	53.97	6.00	5.10	21.26	9.36	4.31
Average Alabama samples	44.32	6.00	4.70	29.60	11.15	4.23

Table 26 shows that the calculated pressed peanut kernels vary from 53.97 to 62.80 per cent. in protein, with an average of 58.78. They vary from 4.28 to 5.10 per cent. in crude fiber, with an average of 4.48. The ten highest in protein average 62.80 per cent. protein, while the ten lowest average 53.97 per cent. These represent the composition of the clean kernels, with the oil brought down to 6 per cent. If the oil and moisture are higher, the protein is, of course, lower.

Table 26 also contains the peanut kernel residue calculated from Alabama peanuts. This contains 44.32 per cent. protein, and thus is decidedly lower in protein than Texas peanuts. Eastern seed, therefore, on an average produces lower grades of peanut cake from Texas seed.

CALCULATION OF HULL CONTENT FROM PROTEIN CONTENT.

The quantity of hulls in peanut products may be estimated from the protein content, but this method is not so accurate as the method of using the crude fiber. Peanuts low in protein will not require so many hulls to bring them to a desired protein content as those high in protein, and hence, while the method is suitable for averages, it is less suitable for individaul cases. The protein content of the kernel varies in different parts of the country.

The following formula may be used:

$$H = \frac{100\ M - P}{1.05\ M - R}$$

This is derived by solving the equations:

$$P = RH + MK$$
$$H + K + .05H = 100$$

In these:

P=protein content of 100 pounds of the product.
R=protein content of 1 pound of the hulls.
H=quantity of hulls in 100 pounds of the product.
M=protein content of the kernel residue in per cent.
K=kernel residue in 100 pounds.

Since the hulls contain only 1 per cent. oil and the final product is assumed to contain 6 per cent. oil, there is an addition of .05 pounds oil for every pound of hulls added.

Let us calculate the hull content of various grades of peanut products, assuming the average, maximum, and minimum protein content of the kernel residue given in Table 26, and taking the average protein content of hull as shown in Table 9.

R=.068 (protein content of hulls)
M=.587 (average protein content of kernel residue)

$$\text{then } H = \frac{58.7 - P}{1.05 \times .587 - .068} = \frac{58.7 - P}{.548}$$

m=.54 (average of ten lowest in protein content of kernel residue)

$$H = \frac{54.0 - P}{1.05 \times .54 - .068} = \frac{54 - P}{.5}$$

m=.628 (average of ten highest protein content of kernel residue)

$$\frac{62.8 - P}{1.00 \times .628 - .068} = \frac{62.8 - P}{.591}$$

The results are given in Tables 27, 28, 29 and 30, which follow.

Table 27.—Composition of peanut products, calculated from 10 lowest in protein.

	Hulls, per cent.	Extra oil, per cent.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.	Per cent. kernel residue.	Productive value.	Digestible protein.
Hulls, ave. (58)	.....	.....	6.76	1.10	60.83	19.64	7.48	4.19	.....	.....	.....
Kernel residue ave, (63)	.....	.....	53.97	6.00	5.10	21.26	9.36	4.31	.....	.....	.....
Product 48% protein	12	0.6	48.00	5.97	11.76	20.94	9.08	4.26	87.4	41.3	16.5
Product 45% protein	18	0.9	45.00	5.97	15.08	20.76	8.94	4.25	81.1	38.5	15.1
Product 43% protein	22	1.1	43.00	5.95	17.30	20.69	8.85	4.23	76.9	36.7	14.4
Product 41.2% protein	25.6	1.3	41.20	5.95	19.30	20.59	8.75	4.21	73.1	35.1	13.9
Product 38.5% protein	31.0	1.6	38.50	5.93	22.30	20.44	8.63	4.20	67.4	32.7	13.0
Product 36% protein	36.0	1.8	36.00	5.93	25.07	20.30	8.51	4.19	62.2	30.4	12.2

Table 28.—Average percentage composition of peanut products calculated from average of Texas peanuts.

	Hulls, per cent.	Extra oil, per cent.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.	Per cent. Kernel residue.	Digestible protein.	Productive value.
Hulls, average (68)	.....	.....	6.76	1.10	60.83	19.64	7.48	4.19	.....	.....	.....
Kernel residue, average (63)	.....	.....	58.78	6.00	4.48	17.38	9.18	4.18	.....	.....	.....
Product 48% protein	19.4	1.0	48.00	6.00	15.46	17.64	8.76	4.14	79.5	15.1	41.04
Product 45% protein	25.0	1.3	45.00	6.00	18.56	17.67	8.64	4.13	73.7	14.2	38.28
Product 43% protein	28.5	1.5	43.00	6.00	20.57	17.73	8.57	4.13	70.7	13.8	36.92
Product 41.20% protein	31.8	1.7	41.20	6.00	22.34	17.75	8.49	4.12	66.5	13.1	34.93
Product 38.5% protein	36.8	1.9	38.50	6.00	25.16	17.84	8.39	4.11	61.3	12.3	32.51
Product 36% protein	41.3	2.2	36.00	6.00	27.75	17.87	8.29	4.09	56.5	11.5	30.27
Product 34% protein	45.0	2.4	34.00	6.00	29.70	17.91	8.20	4.09	52.6	10.9	28.45
Product 32% protein	48.6	2.5	32.00	6.00	31.80	17.99	8.13	4.08	48.9	10.3	26.78
Product 30% protein	52.3	2.7	30.00	6.00	33.85	18.02	8.05	4.08	45.0	9.7	24.91

Table 29.—Composition of peanut products calculated from 10 highest in protein.

	Hulls,	Extra oil,	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.	Per cent. kernel residue.
Hulls, average (68)	.....	.....	6.76	1.10	60.83	19.64	7.48	4.19	.....
Kernel residue, average (63)	.....	.....	62.80	6.00	4.28	13.70	9.02	4.19	.....
Product 48% protein	25	1.3	48.00	5.95	18.38	15.01	8.52	4.14	73.7
Product 45% protein	30.1	1.5	45.00	5.94	21.24	15.29	8.42	4.13	68.4
Product 43% protein	33.5	1.7	43.00	5.94	23.15	15.44	8.35	4.12	64.8
Product 41.2% protein	36.5	1.8	41.20	5.93	24.84	15.61	8.30	4.12	61.7
Product 38.5% protein	41.1	2.1	38.50	5.92	27.44	15.85	8.19	4.10	56.8
Product 36% protein	45.3	2.3	36.00	5.91	29.80	16.07	8.12	4.10	52.4

Table 30.—Average percentage composition of peanut products (Alabama).

	Hulls.	Extra oil.	Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.	Kernel residue.	Digestible protein.	Productive value.
Hulls, average	.....	.....	6.76	1.10	60.83	19.64	7.48	4.19	.....	.....	.....
Kernel residue, average	.....	.....	44.32	6.00	4.70	29.60	11.15	4.23	.....	.....	.....
Product 43% protein	3.3	.2	43.00	6.00	6.55	29.21	11.01	4.23	96.5	37.0	17.4
Product 41.2% protein	7.8	.4	41.20	6.00	9.06	28.70	10.82	4.21	91.8	35.4	16.8
Product 38.5% protein	14.5	.7	38.50	6.00	12.81	27.91	10.54	4.20	84.8	32.9	15.3
Product 36% protein	20.8	1.0	36.00	6.00	16.30	27.24	10.28	4.18	78.2	30.8	14.5
Product 34% protein	25.8	1.3	34.00	6.00	19.12	26.67	10.06	4.16	72.9	29.0	13.7
Product 32% protein	30.8	1.5	32.00	6.00	21.90	26.09	9.85	4.15	67.7	27.1	12.8
Product 30% protein	35.8	1.8	30.00	6.00	24.71	25.50	9.64	4.14	62.4	25.3	12.0

If we compare these tables with the analyses of peanut cake or meal actually on the Texas market, we find that the commercial peanut products are apparently made from a lower grade of nuts than even the ten lowest in protein. The meal with 48 per cent. protein, calculated from the ten lowest samples, contains 6 per cent. oil, 11.76 per cent. fiber and 9.08 per cent. water. The average of the commercial choice Texas peanuts is 49.5 per cent protein, 11.4 per cent. fat, 6 per cent. water and 5.9 per cent. crude fiber. If we reduce the commercial peanut cake to 48 per cent. protein and 6 per cent. fat, it will contain about 8.9 per cent. fiber, or less by nearly 3 per cent. than that calculated from the lowest Texas peanuts. In the same way, the calculated 45 per cent. protein peanut cake contains 6 per cent. fat, 8.94 per cent. water and 15.08 per cent. fiber, while the average commercial peanuts of this grade contain 44.9 per cent. protein, 8.8 per cent. fat, 6.2 per cent. water and 12.1 per cent. crude fiber. With practically the same water and fat content and the same protein content, it contains 3 per cent. less crude fiber.

We observed a similar difference with the whole pressed peanuts. The cause of the difference is not entirely clear, though it may be due to the peanuts used. The difference is, however, to the advantage of the manufactured products.

Table 30 shows the calculated composition of the peanut products from the Alabama peanuts. These peanuts contain less protein than Texas peanuts and make a cake of lower grade. It would approximately correspond to the German analyses.

ESTIMATING THE HULLS IN PEANUT PRODUCTS.

Since the peanut hulls are rich in crude fiber and the meats are low in crude fiber, the hull content may best be calculated from the crude fiber content. The following formula may be used:

$$H = \frac{F - 100K}{C - 1.05K}$$

In which F= crude fiber content of 100 pounds of the sample.
K= the average content fiber of peanut kernels, reduced to 6 per cent. fat. (Table 26.)
R= kernel residue in 100 pounds.
C= .608, which is the average crude fiber content of hulls. (Table 9.)
H= the approximate hull content of 100 pounds of the sample.

This is obtained by solving the two equations:

$$HC+RK=F$$
$$H+R+.05H=100$$

The hulls contain only 1 per cent. fat, while the product derived contains 6 per cent. Hence for each pound of hulls, .05 pounds of fat are taken up.

The calculations would be more accurate if reduction were made to a water and fat-free basis (see Texas Bulletin No. 189, page 45), but on account of the variation in composition of the hulls, this refinement is not advisable. If we used the average for the ten samples of hulls highest and lowest in protein, the factors used would be

C=.55, the average fiber content of the ten samples of hulls lowest in fiber.

C=.676, average fiber content of the ten samples of hulls highest in fiber.

These three formulas are applied to 10 and 20 per cent. crude fiber samples with the following results:

(A) Average hulls $\frac{10.0-4.5}{60.8-4.7} = 9.8\%$ $\frac{20.0-4.5}{60.8-4.7} = 27.6\%$

(B) Hulls lowest in fiber $\frac{10.0-4.5}{55.0-4.7} = 10.9\%$ $\frac{20.0-4.5}{55.0-4.7} = 30.8\%$

(C) Hulls highest in fiber $\frac{10.0-4.5}{67.6-4.7} = 8.7\%$ $\frac{20.0-4.5}{67.6-4.7} = 24.7\%$

Thus, the results would deviate according to the composition of the hulls present. With 10 per cent. fiber, there would be approximately 9.8 per cent. hulls present, but it might be from 8.7 to 10.9 per cent. according to the character of the hulls. With 20 per cent. fiber, there might be from 24.7 to 30.8 per cent. hulls, with an average of 27.6 cent. fat. (Table 26.)

The accuracy of the factor C, the entire average of 58 samples of hulls, may be judges by considering the standard deviation of the crude fiber content of the hulls from the average. The standard deviation of each determination is secured by the formula:

$$S=\sqrt{\frac{ED^2}{N}}$$

in which S is the standard deviation of each determination.

ED^2 is the sum of the squares of the difference between each determination and the average.

N is the number of determinations.

Applied to the crude fiber of the peanut hulls analyzed:

$$S=\sqrt{\frac{1232.3}{58}}=4.6$$

The standard deviation of any single determination is thus 4.6 per cent. The probable error of the average is:

$$E=\frac{.6745\times 5}{\sqrt{N}}$$

equal to .405 in the present case.

FEEDING VALUES OF PEANUT PRODUCTS.

The value of a feed for feeding purposes depends upon its ability to produce energy, fat, body heat, or otherwise to supply the needs of the animal. The energy or heat value is measured by the productive value of the feed. Its ability to form lean meat, etc., is measured by the digestible protein. Both of these factors are very important, but the relative importance in a commercial feed depends upon the kind of animal, the object of feeding, and the home-grown feed available. This matter is discussed in Bulletin No. 170 of this Experiment Station, entitled TEXAS FEEDING STUFFS, THEIR COMPOSITION AND UTILIZATION.

The productive value of a feed may easily be calculated by using the production coefficients described in Texas Bulletin No. 203. The production coefficients of peanut products are given in Table 31. These are based upon digestion experiments and represent the best information available up to date. The production coefficient decreases with the crude fiber content of the peanut product, for the reason that the crude fiber represents hulls, and since the hulls have a much lower feeding value than the kernels, the greater the fiber content the lower the production coefficient.

Table 31.—Productive coefficients of peanut products.

	Protein.	Ether extract.	Crude fibre.	Nitrogen-free extract.	Digestable protein.
Hulls	.143	.453	—.070	.141	.611
Kernel residue	.200	.550	—.050	.200	.860
Product 15.5% crude fiber	.199	.546	—.065	.187	.855
Product 18.6% crude fiber	.198	.544	—.066	.185	.853
Product 20.6% crude fiber	.198	.544	—.067	.183	.851
Product 22.3% crude fiber	.197	.543	—.067	.180	.848
Product 25.2% crude fiber	.196	.542	—.068	.177	.844
Product 27.8% crude fiber	.196	.542	—.068	.174	.840
Product 29.7% crude fiber	.195	.541	—.068	.171	.837
Product 31.8% crude fiber	.194	.540	—.069	.169	.835
Product 33.9% crude fiber	.193	.538	—.069	.167	.830
Whole peanuts	.190	.557	—.060	.032	.808

Table 31 contains the production coefficient of various grades of peanut products. These are calculated on the assumption that the kernels and hulls contained in these products have the production coefficients also given in Table 31, which are based directly on digestion experiments, and on the further assumption that there is no change in digestibility in combining the two. In applying these coefficients, the fiber content of the product should be considered if available, rather than the protein content, as the fiber content better shows the amount of the hulls present, on account of the variation in the protein content of the kernel.

Table 32.—Feeding values of Texas peanut products per 100 pounds.

	Productive value.	Digestible protein.
Hulls, hand separated	0	4.1
Hulls, commercial	1.70	5.0
Peanut cake, choice (average)	20.3	42.6
Peanut cake, prime (average)	17.3	38.6
Whole pressed peanuts (Texas)	14.2	29.8
Whole peanuts, Texas, average	24.6	20.6
Whole peanuts, highest in fat	26.3	20.9
Whole peanuts, lowest in fat	22.7	19.9
Whole peanuts, highest in fibre	22.8	19.5
Peanut hay, mowed	10.9	7.1
Peanut hay, no nuts	10.6	6.1
Peanut hay, with nuts	15.6	11.0
Cotton seed meal, prime, Texas, 1916-17	16.8	37.2
Cotton seed feed No. 4 (41.2) 1916-17	17.0	35.6
Cotton seed feed No. 5 (38.5) 1916-17	16.3	33.1
Cotton seed feed No. 6 (36.10) 1916-17	15.8	31.4
Cold pressed cotton seed	14.6	19.2

Table 32 contains the productive values and digestible protein of Texas peanut products. The analyses of cake and meal given are the average of those actually in the market. Compared with similar grades of Texas cottonseed meal, prime peanut meal or cake is slightly higher in productive value and in digestible protein than prime cottonseed meal. Whole pressed peanuts are slightly lower in productive value and much higher in digestible protein than whole pressed cottonseed. With more experience in their manufacture, the percentage of oil in Texas peanut products will be decreased, and this will decrease the productive value of the products.

Tables 27 and 28 show the digestible protein and productive values of peanut products calculated from Texas analyses of peanuts, reduced to a 6 per cent. fat basis. As compared with cottonseed products, peanut products from the average peanut would be, for choice, about 11 per cent. lower in productive value, and 1 per cent. lower in digestible protein than choice cottonseed meal; for prime, about 14 per cent. lower in productive value and about the same in digestible protein as prime cottonseed meal; for 36 per cent. product, about 23 per cent. lower in productive value and about 1.5 per cent. higher in digestible protein than 36 per cent. Texas cottonseed feed. Thus the peanut product has a lower feeding value than the cottonseed product of the corresponding protein content, and this is due to the fact that the peanut hulls have practically no feeding value, while cottonseed hulls have some feeding value.

It has already been pointed out, however, that the peanut products actually in the market are, from the crude fiber content, better in feeding value than even the average products calculated from the peanuts lowest in protein. Also, on a preceding page, we have pointed out that the peanut products actually in the market compare more favorably with the corresponding cottonseed products than the above figures would indicate. It will take several years' experience to show exactly the feeding value of peanut products. Compared with the corresponding cottonseed products, peanut products made from peanuts lowest in protein (Table 27) are as follows:

Choice Texas peanut meal would have about 6 per cent. less productive value than choice cottonseed meal and practically the same digestible protein.

Prime Texas meal would have about 8 per cent. less productive value than prime cottonseed meal and about 1 per cent. less digestible protein.

Peanut products containing 36 per cent. protein would have about 16 per cent. less productive value and about 2 per cent. more digestible protein than the corresponding cottonseed product.

Thus the difference is greater as the protein content decreases.

PEANUT HULLS.

Table 32 shows that peanut hulls, when cleaned, contain a little digestible protein but have no productive value. Thus clean peanut hulls have practically no feeding value. They can in no sense be considered as a concentrated feed, but must be considered as a roughage. When hay is high, they may be fed as a roughage, to give sufficient volume to the feed, the needs of the animal for protein and energy being met by some other feed. When added to a concentrated feed, they decrease the feeding value of the feed, without any corresponding advantage to the purchaser. If they are fed at all, they should be fed as a roughage, or in complete rations, and not in concentrated feeds.

Commercial peanut hulls contain a small quantity of peanut meats, or immature peanuts, and thus have a higher feeding value than the clean hulls, but the feeding value is still low, even lower than that of rice hulls. As stated above, they may be used as a roughage to fill up an animal, but their use in a concentrated feed is not advisable.

OIL AND CAKE FROM MANUFACTURING PEANUTS.

The quantity of oil, hulls, and other products secured from peanuts will depend upon the quality of peanuts used, the grade of product made, and the success secured in extracting the oil.

According to Kilgore of the North Carolina Experiment Station, a ton of Spanish peanuts yields 70 to 80 gallons of oil and 1300 to 1400 pounds of cake when the whole peanuts are pressed, the by-product containing 30 to 35 per cent. protein and 6 to 8 per cent. fat; when hulled peanuts are used, the yield is 100 to 115 gallons oil and 1100 to 1200 pounds cake per ton, containing 40 to 50 per cent. protein, usually 48 per cent.

According to Thompson and Bailey, Farmers' Bulletin No. 751,

United States Department of Agriculture, Spanish peanuts will yield 630 pounds oil (84 gallons) per ton of farmers' stock, and Virginia peanuts will yield 430 pounds, or 57 gallons, per ton of farmers' stock. This is when the peanuts are shelled and a cake containing 9 per cent. oil is made.

Table 33.—Oil and cake from clean Texas peanuts (basis of 6 per cent extraction) per ton.

	Pounds oil.	Gallons oil.	Pounds cake.	Protein in product per cent.
Peanut kernels, clean, average	908	121.1	1192	58.8
Peanut kernels, highest in fat	958	127.7	1042	59.3
Peanut kernels, lowest in fat	864	115.2	1136	55.3
Whole peanuts, average	652	86.9	1348	37.9
Whole peanuts, highest in fat	712	94.9	1288	40.2
Whole peanuts, lowest in fat	588	78.4	1412	34.9
From whole peanuts, average	670	89.3	1030	48.0
From whole peanuts, average	666	88.8	1103	45.0
From whole peanuts, average	663	88.4	1163	43.0
From whole peanuts, average	660	88.0	1222	41.2

Table 33 shows the theoretical quantities of oil and product of the grade given, which may be secured from clean Texas peanuts, calculated on a 6 per cent. basis.

The quantity of oil from the whole peanuts varies from 78.4 to 94.9 gallons per ton of clean peanuts, a difference of 16.5 gallons.

The quantity of oil also decreases as the quantity of cake made increases. It would be, on a 6 per cent. basis, .8 gallons for each 100 pounds additional cake.

If cake is made containing more than 6 per cent. oil, the yield of oil would, of course, be correspondingly decreased. Each additional per cent. of oil left in the cake would decrease the yield of oil about 1.5 gallons per ton of whole clean peanuts.

The yield per ton of farmers' stock would depend upon the percentage of whole peanuts present—that is, the amount of trash, sticks and pops present, also immature nuts and moisture. The average per cent. of pops in the nuts given in Table 3 is 2.1 per cent.; of trash, sticks, et cetera, 4.4 per cent.; or a total of 130 pounds per ton. The pops were as much as 5.8 per cent., and the trash as much as 32.2 per cent. The average amount of pops and trash given in Table 4 is 13.9 per cent. This would be nearly 280 pounds per ton. The trash and pops will decrease the yield of oil and cake per ton of farmers' stock.

There is also an invisible loss in manufacturing, due to loss of moisture, particles of meats, perhaps settlings in the oil, and perhaps also to trash, et cetera, in the seed, which is difficult to estimate.

The total loss per ton of farmers' stock is estimated by some to be 200 pounds per ton, or 10 per cent. Others put it at 220 pounds.

GRADES OF PEANUTS.

Farmers' stock peanuts vary in the quantity of trash, pops and immature nuts contained in them, as seen in the preceding section, and the oil produced and the cake produced vary likewise. It is thus fair

that grades should be established so that farmers producing clean grade nuts may be paid more per bushel than farmers producing trashy poor peanuts. If both are paid the same, there is no inducement to have the nuts properly cleaned and shelled. If care is taken in the threshing, most of the pops may be blown out with the hay, and the dirt and stems may largely be separated by the use of proper screens.

In the opinion of the writer, the grades of peanuts should be based upon the percentages of moisture and peanut kernels present in the farmers' stock. The trash and sticks will decrease the quantity of kernels. A well-filled nut should command a higher price than those with a large percentage of hulls. The following is suggested for consideration:

Choice unshelled peanuts should contain not less than 75 per cent. kernels or more than 7 per cent. moisture.

Prime unshelled peanuts should contain not less than 65 per cent. kernels or more than 9 per cent. moisture.

The definitions adopted by the Texas Cottonseed Crushers, 1917, are embodied in Rule 17, as follows:

Sec. 1. Choice Unshelled Peanuts shall be recleaned, sound, dry, fully matured, free from dirt, stems, pops, trash or other foreign matter, reasonably free from shelled peanuts, and must not have moisture content in excess of 7 per cent.

Sec. 2. Prime Unshelled Peanuts shall be equal in grade to the average unshelled peanuts for the season of the year in which they are sold, and shall be dry, and shall not contain more than 2 per cent. of dirt and not more than 5 per cent. of stems, pops, trash or other foreign matter, and must not contain more than 3 per cent. of damaged peanuts and must not have a moisture content in excess of 10 per cent.

Sec. 3. Off Unshelled Peanuts shall be settled for on their merits and comparative value as against the value of Prime Unshelled Peanuts.

Sec. 7. Weights. Unshelled peanuts shall be sold on a gross weight per 100 pounds, or a ton of 2000 pounds, whether sacked or in bulk.

Sec. 8. Sampling. Bulked peanuts shall be sampled according to the rule governing the sampling of bulk cotton seed.

Sacked peanuts shall be sampled by taking a fair representative sample from at least 10 per cent. of the sacks.

The samples drawn as above directed to be thoroughly mixed and from this mixture take 100 peanuts, same to be shelled and contents graded according to the quality. All peanuts showing color darker than natural color of peanuts, or containing mold, to be classed as "Off Peanuts."

STANDARDS FOR BY-PRODUCTS.

The following standards for peanut by-products have been adopted by the Texas Feed Control, July, 1917.

Choice Peanut Meal is the product from the kernels of sound peanuts, free from excess of hulls and other foreign materials. It must be finely ground, of sweet odor, and must contain not less than 48 per

cent. of protein, not less than 7 per cent. of fat, and not more than 9 per cent of crude fiber.

Prime Peanut Meal is the product from the kernels of sound peanuts, free from excess of hulls and other foreign materials. It must be of sweet odor, and contain not less than 45 per cent. of protein, not less than 6 per cent. of fat and not more than 14 per cent. of crude fiber.

Peanut Cake shall correspond to peanut meal in composition and as to standard.

Choice Whole Pressed Peanuts is the product resulting from subjecting the whole, sound, mature, clean peanut, free from sticks, stems and dirt to pressure for the extraction of oil, and includes the entire peanut less the oil extracted. It must contain not less than 36 per cent. of protein and not more than 22 per cent. of crude fiber.

Prime Whole Pressed Peanuts is the product resulting from subjecting the whole, sound, mature, clean peanuts, reasonably free from sticks and stems, to pressure for the extraction of oil, and includes the whole peanut less the oil extracted. It must contain not less than 34 per cent. of protein and not more than 24 per cent. of crude fiber.

Ground Whole Pressed Peanuts shall correspond to Whole Pressed Peanuts in composition and as to standard.

DEFINITIONS OF COTTONSEED CRUSHERS.

Definitions adopted in May, 1917, by the Texas Cottonseed Crushers and embodied in Rule 17, are as follows:

Sec. 4. Choice Whole Pressed Peanuts is the product resulting from subjecting the whole, sound, mature, clean peanut, free from sticks, stems and dirt, to pressure for the extraction of oil, and includes the entire peanut less the oil extracted. It must contain not less than 36 per cent. of protein and not more than 22 per cent. of crude fiber.

Sec. 5. Prime Whole Pressed Peanuts is the product resulting from subjecting the whole, sound, mature, clean peanuts, reasonably free from sticks and stems, to pressure for the extraction of oil, and includes the entire peanut less the oil extracted. It must contain not less than 34 per cent. of protein and not more than 24 per cent. of crude fiber.

Sec. 6. Ground Whole Pressed Peanuts shall correspond to Choice and Prime Whole Pressed Peanuts in composition and as to standards.

Note.—All deductions on above grades for off quality shall be made on basis of 1 per cent. of contract price for each 1 per cent. off quality.

INTERSTATE DEFINITIONS.

The following definitions were adopted by the Interstate Cottonseed Crushers' Association, May, 1917:

RULE 24.—PEANUT CAKE.

Sec. 1. Choice Peanut Cake is a product of sound peanuts, sweet in odor, not burned in cooking, and shall contain not less than 44 per per cent. of protein or 50 per cent. of combined protein and fat.

Sec. 2. Prime Peanut Cake is a product of the peanut, sweet in odor, and shall contain not less than 34 per cent. protein or 40 per cent. of combined protein and fat.

Sec. 3. Choice Peanut Meal is a ground product of Choice Peanut Cake and by analysis must contain not less than 44 per cent. of protein or 50 per cent. of combined protein and fat.

Sec. 4. Prime Peanut Meal is a ground product of Prime Peanut Cake and by analysis must contain at least 34 per cent. of protein or 40 per cent. of combined protein and fat.

The definition of Choice Peanut Meal, 51 per cent. protein and fat. appears to be a fair definition for Eastern peanut meal, though not for Texas meal, which should contain 48 per cent. protein.

The definition for Prime Peanut Meal, 34 per cent. protein, would, however, permit the sale of Whole Pressed Peanuts under the name of Peanut Meal. Whole Pressed Georgia peanuts might run as high as 37 per cent. protein.

Table 34.—Analyses peanut oil meal.

	Protein.	Ether extract.	Crude fiber.	Water.
Bulletin 420, Geneva, N. Y., 1916	38.8	10.5	3.1	.....
Bulletin 420, Geneva, N. Y., 1916	30.6	9.3	7.9	.....
Mass. Control Series Bulletin No. 3, 1915	45.53	9.68	3.66	.....
Mass. Control Series Bulletin No. 3, 1915	33.36	9.03	8.40	.....
Mass. Control Series Bulletin No. 5, 1916	48.74	7.41	4.20	.....
Mass. Control Series Bulletin No. 5, 1916	35.03	10.03	8.01	.....
Bulletin 283, N. J. Station, 1915	32.69	8.97	8.64	5.32
Bulletin 283, N. J. Station, 1915	38.75	9.05	4.22	4.15
Bulletin 295, N. J. Station, 1916	47.56	7.90	4.46	7.92
Bulletin 295, N. J. Station, 1916	35.44	13.29	6.59	6.90
Bulletin 295, N. J. Station, 1916	33.50	10.00	9.37	7.60
Bulletin 295, N. J. Station, 1916	36.06	9.84	6.68	7.33

On the other hand, we have compiled a number of analyses of peanut meal, made by the New York, New Jersey and Massachusetts Feed Controls. (Table 34.) Several of the analyses contain from 30 to 33 per cent. protein and 8 to 9 per cent. crude fiber, and would thus be classed as peanut meals. We would judge from this that there is such a wide variation in peanuts, that some whole pressed peanuts and some peanut meals would have the same protein content. That is to say, the lower grades of peanut meals produced in some sections of the country may overlap with higher grades of whole pressed peanuts. If this is really the case, the protein content cannot be used to distinguish low-grade peanut meal from whole pressed peanuts, but recourse must be had to the crude fiber content.

ACRE YIELD.

The peanut will do well on sandy soil not suited to corn or cotton, and stands dry weather better than corn. Peanuts also take part of their nitrogen from the air, while corn takes all it uses from the soil Hence, in this respect peanuts are not so hard upon the soil as corn, will grow on soil poorer in nitrogen, and, if fed and the manure returned to the soil, will make the soil richer than it was before.

Table 35.—Food value produced per acre by peanuts, etc.

	Total weight.	Productive value, pounds.	Digestible protein, pounds.
Peanuts—			
38 bushels nuts	1140	280	235
Hay, without nuts	2850	301	174
Total	.....	581	409
Prime peanut meal	590	102	235
Hay	2850	301	174
Total	.....	403	409
Corn—			
25 bushels corn	1800	371	117
Stover	500	35	13
Total	.....	406	130
Corn (silage)	20,000	540	200
Sorghum (silage)	20,000	540	10
Oats—			
25 bushels oats	750	98	67
Straw	1000	70	8
Total	.....	168	75

Table 35 shows the yield of food values per acre of peanuts and some other crops, compared on the basis of digestible protein and productive values. It also shows the plant food withdrawn from the soil by the crops mentioned.

Peanuts thus produce a crop of high food value per acre. As they will stand dry weather better than corn, and may be grown on soil which does not produce corn well, their growth offers decided advantages. If the hay and nuts are removed, they add nothing to the fertility of the soil, but if grazed off, or hogged off, they add both vegetable matter and nitrogen which they have gathered from the air, thus making the soil better fitted to grow other crops.

PEANUTS AS A HUMAN FOOD.

Peanuts are rich in protein and oil, and for this reason have a high value as a human food. The value of a food for human purposes is measured by the digestible protein and productive value. Table 34 compares shelled peanuts with some other foods, assuming 90 per cent. digestibility. They are seen to compare favorably with meat. The high value of peanuts as a human food is not often appreciated. Peanuts are one of the richest foods given in Table 36.

Table 36.—Relative value of peanuts as a human food.

	Protein.	Fat digested including carbohydrates divided by 2.2.	Relative productive value.
Peanut kerneis (Texas)	29.0	47.0	62
Peanut butter	25.0	48.0	61
Peanut meal (pure)	52.0	12.0	38
Eggs	12.8	11.4	18
Beef flank	19.0	20.0	30
Beef loin	15.9	16.1	24
Mutton	18.1	16.6	26
Wheat bread	7.8	25.5	30
Cottonseed meal corn bread	7.9	18.4	22
Corn bread	3.7	18.4	20
Wheat flour	9.7	34.5	40
Cottonseed flour	39.3	18.7	38
Butter	0	80.0	80
Cottonseed meal corn bread	14.0	32.2	39

A bulletin entitled HOW TO GROW THE PEANUT AND 105 WAYS OF PREPARING IT FOR HUMAN CONSUMPTION is published as Bulletin No. 31 of the Experiment Station at Tuskegee, Alabama, and is of decided interest in this connection and especially at the present time.

PEANUT BUTTER.

Peanut butter is made by roasting and grinding the peanuts, after the red outer bran, immediately around the kernel, has been removed. Some manufacturers of peanut butter remove the germ also. Peanut butter is easily made at home.

Table 37.—Peanut butter—percentage composition

Laboratory number.	Protein.	Ether extract.	Crude fibre.	Nitrogen free extract.	Water.	Ash.
9632	29.80	53.35	1.99	10.82	1.18	2.06
9442	28.78	53.32	2.33	11.28	1.34	2.95

Peanut butter compares favorably with ordinary butter (Table 34) and, in addition, contains protein. Table 37 contains some analyses.

Peanut butter is an excellent substitute for dairy butter on bread or crackers or in sandwiches, and is usually much less expensive.

PEANUT OIL.

Crude peanut oil has a yellow color and the odor and taste of peanuts. Refined peanut oil is almost colorless and has no taste or odor of peanuts but is tasteless and odorless.

Peanut oil does not decompose as easily at high temperatures as some other oils, and hence is better adapted to cooking in oil, frying, et cetera, than these oils. It may be strained off, allowed to settle, and used again for frying purposes.

Peanut oil is an excellent oil and has a high food value. It is equal

to olive oil or cottonseed oil in this respect. Its keeping properties should be as good as other oils.

Some manufacturers of peanut and cottonseed oils do not thoroughly clean the presses, pipes, et cetera, of cottonseed oil before manufacturing the peanut oil; for this reason, the peanut oil may contain some cottonseed oil, which shows readily in a chemical test.

MINERAL CONSTITUENTS.

Tables 38, 39 and 40 show the mineral constituents of peanut products. A knowledge of this is important, first, to show the draft of the peanut on the soil, and, second, to show the mineral food which the animal receives.

Table 38.—Mineral constituents of peanut hay—percentage.

Laboratory number.	Phosphoric acid.	Potash.	Lime.	Magnesia.	Insoluble ash.
4259-60	.33	1.02	1.57	1.30	1.94
11212-3—11213	.29	1.52	1.58	0.95	1.72
11232-5	0.25	1.65	.....	.....	.....
12919	.....	.99	1.53	1.27	8.77
12920	.....	1.05	1.54	1.23	8.29
9814	.28	1.47	2.13	.76	2.96
9815	.29	1.42	2.24	.72	2.79
Average	.288	1.303	1.765	1.038	4.41

Table 39.—Mineral constituents of peanut kernels—percentage.

Laboratory number.	Phosphoric acid.	Potash.	Lime.	Magnesia.	Insoluble ash.
11569	.63	.72	.....	.....	.....
12755	.92	.....	.....	.....	.....
12617	.85	.76	.12	.35	.06
12605	.78	.78	.13	.36	.08
12619	.70	.89	.14	.33	.02
11237	.....	.84	.10	.34	.17
11513	.79	.97	.13	.34	.06
11514	.88	.88	.14	.35	.08
12446	.....	.....	.03	.35	.15
12447	.....	.....	.11	.36	.10
12448	.....	.87	.11	.36	.10
12467	.....	.....	.09	.32	.13
12468	.....	.....	.11	.34	.11
12469	.....	.....	.09	.31	.14
12735	.94	.....	.....	.....	.....
12756	.69	.....	.....	.....	.....
12757	1.07	.....	.....	.....	.....
12611	.76	.90	.10	.35	.05
11508	.90	.60	.....	.....	.....
12612	.92	.91	.11	.39	.08
12614	.60	.74	.13	.29	.05
12623	.61	.85	.10	.35	.04
Average	.8027	.82	.109	.34	.088

Table 40.—Mineral constituents of peanut hulls.

Laboratory number.	Phosphoric acid.	Potash.	Lime.	Magnesia.	Insoluble ash.
12788	.....	1.27	.....	.....	.....
12931	.....	1.28	.....	.....	.....
11233	.15	.87	.25	.27	8.02
11236	.15	.91	.26	.28	6.83
11563	.20	.82	.45	.28	4.38
11570	.11	.90	.30	.18	0.69
12436	.12	.93	.25	.21	0.66
12437	.15	.83	.31	.26	.95
12438	.....	.....	.35	.27	1.50
12461	.11	1.61	.57	.29	.30
12462	.12	1.62	.27	.18	.49
12463	.....	.....	.27	.30	.52
12464	.11	1.45	.27	.20	.52
12465	.....	1.46	.24	.24	.38
12466	.22	1.39	.....	.....	.....
12491	.....	.....	.27	.28	.58
12492	.17	.....	.28	.24	.59
12493	.....	.....	.26	.27	.51
12711	.....	.78	.....	.....	.....
12713	.....	1.67	.....	.....	.....
12795	.17	.....	.....	.....	.....
12932	.....	0.74	.....	.....	.....
Average	.15	1.16	.31	.25	1.79

SUGARS, STARCHES AND PENTOSANS.

Tables 41 and 42 contain the sugars, starch and pentosan contents of peanut products. These are related to other investigations we are carrying out, and are given here for reference, so we will not discuss them further.

Table 41.—Sugar, starch and pentosans in peanut hulls.

Laboratory number.	Reducing sugar.	Di. Sugar.	Starch.	Pentosans.
12781	.48	3.40	.17	18.44
12785	.27	2.06	.44	18.00
12788	.06	1.24	.83	17.47
12791	.50	2.53	.70	.....
12796	.....	.....	.47	.....
12805	.....	.....	.76	17.73
12806	.....	.....	1.07	17.68
12808	.....	.....	1.08	.....
12928	.....	.....	1.01	.....
12931	.....	.....	.86	.....
12930	.....	.....	1.01	.....
11233	.32	1.23	.97	15.90
11236	.36	1.36	.95	15.81
11436	.....	.....	.....	18.20
11437	.....	.....	.....	18.52
12438	.....	.....	.....	18.13
12461	.....	.....	.....	18.05
12462	.....	.....	.....	18.94
12463	.....	.....	.....	18.69
12464	.....	.....	.....	17.04
12465	.....	.....	.....	18.96
12466	.....	.....	.....	17.64
12491	1.67	1.31	.....	.....
12492	1.53	0.98	.....	.....
12493	1.60	1.14	.....	.....
12795	.....	.....	.....	18.26
2	.09	1.55	.....	.....
3	.10	.03	.....	.....
4	.07	3.61	.....	.....
6	.09	0.75	.....	.....
7	.12	1.29	.....	.....
9	.09	1.60	.....	.....
90	.27	1.15	.....	.....
2	1.60	2.88	.....	.....
12977	0.76	2.84	2.37	.....
Average	.588	1.72	.737	17.82

Table 42.—Sugars, starch and pentosans of peanut kernels.

Laboratory number.	Reducing sugar.	Di. sugar.	Starch.	Pentosans.
12619	.10	2.83	1.47	2.50
12605	.07	3.36	1.87	2.57
12742	.10	4.93	2.66	.....
12940	.07	4.46	1.48	.....
12743	.12	3.31	2.20	.....
12735	.28	3.14	.....	.....
12733	.07	2.95	1.73	2.50
12694	.06	3.01	.....	.....
12693	.10	2.88	.....	.....
12681	.10	3.09	2.04	.....
12618	.09	3.12	1.63	.....
12617	.07	2.31	.....	2.72
12755	.....	.....	.94	2.72
12736	.....	.....	1.28	2.91
12623	.....	.....	.....	2.56
11237	.08	5.21	.....	.....
12433	.....	.....	.....	2.65
12435	.....	.....	.....	2.68
12445	.....	.....	.....	2.58
12468	.....	.....	.....	2.20
12469	.....	.....	.....	2.39
12741	.....	.....	2.01	2.69
12757	.....	.....	3.18	.....
12938	.....	.....	.....	2.56
11508	.10	3.48	.....	.....
Average	.10	3.43	1.71	2.59

ASHES OF HULLS.

Table 43 contains the analyses of a sample of peanut hull ashes. Consideration of Table 38, in connection with the ash content of peanuts, shows that peanut hull ashes should be rich in potash. If pure, they should contain nearly 25 per cent. potash.

Table 43.—Peanut hull ashes, percentage.

Potash	10.21
Phosphoric acid	2.50
Lime	8.09
Magnesia	3.60
Insoluble ash	29.83

STEMS.

Table 44 contains some miscellaneous analyses of stems, cleanings, et cetera. As these cleanings contain leaves, et cetera, they should have some feeding value, but they are likely to contain much dirt, and this is not a good thing to feed.

Table 44.—Miscellaneous samples.

Lab. No.		Protein.	Ether extract.	Crude fiber.	Nitrogen-free extract.	Water.	Ash.
11248	Peanut stalks and fiber along top of nuts	9.47	1.73	24.75	49.45	10.65	3.95
12730	Cleanings from peanuts (stems, leaves and immature nuts)	15.19	2.73	12.09	48.25	7.38	14.36
12616	Cleanings (leaves, stems, etc.)	8.09	3.46	50.97	27.14	6.78	3.56

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SUMMARY.

Peanut hay without nuts has a higher productive value than alfalfa but less digestible protein. Peanut hay with nuts has a high feeding value on account of the nuts present.

Whole Texas peanuts average 25.5 per cent. protein and 36.6 per cent. fat from 58 analyses. They vary considerably.

Texas peanuts are richer in protein than peanuts grown in the East, though some Eastern peanuts may be fully equal to Texas peanuts.

Pure peanut hulls are high in fiber and have no feeding value, though they may be used as a filler. Commercial hulls contain some kernels and have a feeding value about one-half that of rice hulls or one-third that of cottonseed hulls.

Peanut kernels are rich in protein and fat, Eastern kernels averaging less protein than Texas.

Individual peanut kernels may vary decidedly in protein and fat content. A sufficient number of kernels to overcome individual variations should be taken for analyses.

Texas Whole Pressed Peanuts calculated from the peanuts should average 37.9 per cent. protein and 25.7 per cent. fiber, but the samples on the market average less fiber.

Two grades of Texas Whole Pressed Peanuts should be made, on account of the variation in the composition.

Texas peanuts can be made into choice meal containing 55 per cent. protein and fat combined, or prime meal containing 51 per cent. protein and fat combined. The crude fiber content calculated from the peanuts analyzed is more than that found in the peanut cake or meal actually on the market.

Methods are given for the calculation of the Whole Pressed Peanuts or Peanut Cake or Meal secured from a sample of peanuts of known analysis.

A method is given for calculating the hull content of peanut by-products from the fiber content.

The feeding values of peanut by-products are discussed. Choice Peanut Cake and Prime Peanut Cake actually on the Texas market are practically equal to Prime or Choice Cottonseed Cake on the market. Whole Pressed Peanuts are practically equal to Whole Pressed Cottonseed in productive value, though they contain much more digestible protein.

The yields of oil and cake are discussed.

Grades of peanuts are discussed. The kernel content is an important character.

Standards for peanut products corresponding to cottonseed products are desirable from a manufacturing standpoint, but, on account of the high protein content of peanut kernels, it is not advisable to adopt the lower standards for peanut products.

If the definition of prime peanut meal as containing 34 per cent. protein proposed by the Interstate Cottonseed Crushers' Association should be adopted, it would permit the sale of whole pressed peanuts under the name of prime peanut meal. There are some Eastern peanut meals that contain only 34 per cent. protein, and it is possible that a definition cannot be made on a protein basis that will distinguish between whole pressed peanuts and the true peanut meal low in protein.

Peanuts are an excellent human food. Peanut oil is excellent as a cooking and table oil.

Mineral constituents, starches, sugars, and pentosans, are given.